DEFENSE SPECIAL WEAPONS AGENCY

The Defense Special Weapons Agency (DSWA) is seeking small businesses with a strong research and development capability and experience in nuclear weapon effects, phenomenology, operations and counterproliferation. (Note we are not interested in nuclear weapon design or manufacture.) DSWA invites small businesses to send proposals to the following address:

Defense Special Weapons Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Special Weapons Agency
ATTN: AM/SADBU, Mr. Bill Burks
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-5021

DNA has identified 23 technical topics numbered DSWA96-001 through DSWA96-023. These are the only topics for which proposals will be accepted. The current topics and topic descriptions are included below. These topics were initiated by the DNA technical offices which manage the research and development in these areas. Several of the topics are intentionally broad to ensure any innovative idea which fits within DSWA's mission may be submitted. Proposals do not need to cover all aspects of these broad topics. Questions concerning the topics should be submitted to:

Defense Special Weapons Agency
ATTN: PMX, Mr. Ronald Yoho
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-6475

DSWA selects proposals for funding based on the technical merit, criticality of the research, and the evaluation criteria contained in this solicitation document. As funding is limited, DSWA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DSWA may fund more than one proposal under a specific topic or it may fund no proposals in a topic area. Proposals which cover more than one DSWA topic should only be submitted once.

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Subject Index for the DSWA SBIR Solicitation

DSWA TOPIC DESCRIPTIONS

DSWA 97-001 TITLE: **Nuclear Weapon Effects Phenomenology**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative algorithms to improve our understanding of nuclear weapon effects and the implementation of these algorithms

DESCRIPTION: To improve the understanding of the impact of nuclear weapons under battlefield conditions, we require more accurate, efficient, user-friendly methods of calculating and displaying the affects o nuclear scenarios and their operational impact. Areas of interest include: improved accuracy even as calculational times are minimized: reliance on basic physical principles validated by measured test results: faster running calculations; and new improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects and their system impacts. Nuclear weapon effects include airblast, ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; and dust cloud formation.

Improved methods are required for the management of technical information that relates to archival of nuclear weapon phenomenology and test data as well as input to and retrieval of such data archives. Methods for developing unifying test data standards devised with application beyond just nuclear test effects are needed to improve data processing efficiency and reduced hardware and software specific requirements.

PHASE I: The research will demonstrate the feasibility of the proposed approach to improve the understanding of nuclear weapon effects or the archival and ease
of use of stored data.

PHASE II: The research concepts developed in Phase I will be further developed and incorporated into appropriate codes.

COMMERCIAL POTENTIAL: Computer codes related to earthquake effects, pollution transport, signal propagation, data archival, and test standards for data.

REFERENCES:
(1) DNA EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 97-002 TITLE: **Simulation of Nuclear Weapon Effects on Communication, Sensor Operability, and Signal Propagation**

CATEGORY: Exploratory Devleopment, Survivability and Hardening

OBJECTIVE: Investigate the simulation of effects of nuclear weapon explosions on electromagnetic and opticla/signals, and the subsequent impact on the performance of communications and sensor systems.

DESCRIPTION: The Defense Special Weapons Agency (DSWA) is interested in the basic physical processes which describe the interaction of nuclear weapons with the atmosphere, which create environments that degrae the propagation of communication and radar signals and tha tcontaihn optical clutter backgrounds which degrade optical sensor systems. Part of DSWA's mission is to simualte effects on and determine mitigation methods for DoD systems such as satellite communications, VLF/LF comunications, HF/VHF/UHF communications, radar systems, and optical sensor systems. Areas of interest include the development of improved communications and sensor methods to mitigate atmospheric effecfgs on systems and the development of an applicatiohn of simulators to test DoD systems in stressed environments.

PHASE I: Demonstrate the feasibility of the proposed investigation to advance the understanding of any of the areas described above.

PHASE II: Continue the investigation to develop a product or result that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Commercial communication systems and space systems and space sensors, and predictions of operational effects produced by solar events.

REFERENCES:
(1) EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, the Effects of Nuclear Weapons

DSWA 97-003 TITLE: **Nuclear Weapon Effects on Electronics**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Explore the effects produced by nuclear radiation and electromagnetic pulse on electronics

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear-weapon produced radiation on electronics, electronic systems, opto-electrical devices, and sensors in the phenomenology areas of: a) Transient Radiation Effects on Electronics (TREE); b) High Altitutde Electromagnetic Pulser; (HEMP); c) System Generated EMP (SGEMP); and d) Source Region EMP (SREMP) are of interest to DSWA. Particular areas of concern include: methods by which designers of space, strategic and tactical systems can assess their susceptibility to these effects; technologies to reduce the susceptibilities of electronic systems and microelectronic devices (especially those with submicron feature sizes) to acceptable levels; and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to model the nuclear radiation and electromagnetic system effects in the distributed interactive simulation (DIS) format are required. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects are required.

PHASE I: Initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

PHASE II: Continue the investigation which was begun in Phase I to fully develop and demonstrate the proposed approach.

COMMERCIAL POTENTIAL: Commercial satellites and electromagnetic interference/ compatibility.

REFERENCES:
(1) DNA EM-1, Capabilities of Nuclear Weapons, TREE
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 97-004 TITLE: **Modeling of Nuclear Weapon Effects on Communication, Sensor Operability, and Signal Propagation**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the modeling of effects of nuclear weapon explosion on electromagnetic and optical/signals, and the subsequent impact on the performance of communication and sensor systems.

DESCRIPTION: The Defense Special Weapons Agency (DSWA) is interested in the basic physical processes which describe the interaction of nuclear weapons with the atmosphere, which create environments that degrade the propagation of communication and radar signals and that contain optical clutter backgrounds which degrade optical sensor systems. Part of DSWA's mission is to predict effects on and determine mitigation methods for DoD systems such as satellite communications, VLF/LF communications, HF/VHF/UHF communications, radar systems, and optical

sensor systems. Areas of interest include mechanisms for the coupling of nuclear weapons energy to the atmosphere; the development of structure in weapon produced plasmas and molecular emitters; the chemical processes which give rise to the optical emissions; the transport and final deposition of nuclear debris; the effects of degraded signal propagation on the performance of communication systems and radars; and the prediction of the effects of optical clutter backgrounds on the performance of optical sensor systems.

PHASE I: Demonstrate the feasibility of the proposed investigation to advanced the understanding an any of the areas described above.

PHASE II: Continue the investigation to develop a product or result that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Commercial communication systems and space sensors, and predictions of operational effects produced by solar events.

REFERENCES:
(1) EM-1, Capabilities of Nuclear Weapons
(2) Glasstone, The Effects of Nuclear Weapons

DSWA 97-005 TITLE: **Nuclear Hardening and Survivability**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative technologies to improve the nuclear hardening and survivability of DoD systems

DESCRIPTION: Improved techniques for nuclear hardening and survivability of weapon systems, against nuclear weapons effects are required. These techniques should protect the system against the effects of blast, thermal, nuclear radiation, and electromagnetic pulse. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulse if of interest. Systems include planned and operational, strategic and tactical, ground mobile, missile, aircraft, ships and submarines and space systems and their subsystems and components.

PHASE I: Demonstrate the feasibility and usefulness of the proposed technique.

PHASE II: Fully develop the proposed technique and characterize its usefulness in both technical and cost terms

COMMERCIAL POTENTIAL: Improved buildings, electronics, aircraft, satellites and better electromagnetic shielding.

REFERENCES:
(1) Mil-Std-188-125
(2) Mil-Hdbk-423
(3) DSWA EM-1, Capabilities of Nuclear Weapons
(4) Glasstone, The Effects of Nuclear Weapons

DSWA 97-006 TITLE: **Radiation Hardening of Microelectronics**

CATEGORY: Exploratory Development, Electronic Devices

OBJECTIVE: Develop and demonstrate technology to: (1) radiation harden; (2) improve reliability and electrical performance; (3) improve radiation hardness and reliability assurance methods; and (4) develop radiation - performance predictive device and circuit model and (5) characterize the radiation and reliability response of semiconductor devices (microelectronics and opto-electronics) including warm and cold operation metal oxide semiconductor (MOS), bipolar, and compound material technologies.

DESCRIPTION: The trend in semiconductor integrated circuits and sensors is toward increasingly higher levels of integration density, higher speeds, higher on-chip circuit complexity, lower voltage and power, and larger die size. All of these trends have exacerbated the problems associated with radiation hardening reliability, and testability. In addition, improvements in material science have lead to the introduction of a wide variety of compound semiconductor materials into microelectronic and opto-electronic applications. The radiation and reliability responses of these materials is lacking or unknown.

Thus, it is the objective of this topic to develop and demonstrate innovative technology and methods to: (1) ensure that these devices can operate in a radiation or other stressing environment (e.g., very high or low temperatures); (2) improve device reliability; (3) improve producibility and yield; (4) develop cost-effective hardness and reliability assurance methods; (5) develop radiation performance predictive models for devices and circuits: (6) investigate and characterize the radiation response and reliability performance of these devices and associated materials; and, (7) maintain device performance without degrading robustness. The development of technologies which enhance reliability, producibility, and yield will support the commercial semiconductor sector. In addition, the development of methods to improve the survivability of microelectronics in severe stressing environments is directly related to the commercial semiconductor and electronics industries.

PHASE I: The research will demonstrate the feasibility of the proposed technology and methods concepts.

PHASE II: The research concepts developed in Phase I will be demonstrated or reduced to engineering practice.

COMMERCIAL POTENTIAL: Robust microelectronics, satellites, high temperature sensors.

DSWA 97-007 TITLE: **Nuclear Weapon Effects Simulation Technology**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation technologies.

DESCRIPTION: Simulators are needed to provide experimental data for development of numerical simulations of nuclear weapons effects; simulate one or more nuclear weapons effects at laboratory size scale; and improve weapon system test capability. Simulation requirements include airblast over various surface conditions, dusty flow, dust lofting, shock propagation in rock, water shock, thermal radiation, EMP, and nuclear radiation.

Existing large scale simulators are often expensive and time consuming to operate, and require travel to an explosive test site. Small scale simulators are needed to provide extensive data to supplement the limited amount of data available from the large scale simulators. Innovative simulators are needed which are economical and simple to operate. Innovative ideas are needed on how to use very small scale simulators to produce useful information.

PHASE I: Demonstrate the basic simulator concept.

PHASE II: Demonstrate a laboratory scale simulator and produce useful data.

COMMERCIAL POTENTIAL: Numerical analysis, metrology, earthquake, hurricane and tornado survivability.

REFERENCES: DASIAC-SR-92-0006, Guide to Nuclear Weapons Effects Simulation Facilities and Techniques - 1992 Edition.

DSWA 97-008 TITLE: **Instrumentation and Diagnostics**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Advance the state-of-the-art in nuclear and conventional weapon effects instrumentation.

DESCRIPTION: Instrumentation is used for measuring nuclear and conventional weapon effects including: phenomenology parameters and the response of test items exposed to conventional or simulated nuclear weapon effects.

The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in blast and shock tests, or tests involving high levels of X-ray , gamma, or neutron radiation. Instrumentation is needed for the following types of tests: airblast, ground shock, dusty flow, dust lofting, water shock, shock propagation in rock, High Explosive (HE), nuclear radiation (x-rays and gamma rays), thermal radiation, electromagnetic pulse (EMP) (high altitude or systems generated) and for improved data acquisition (transmission and recording). Desirable improvements include costs, ease of use, precision, accuracy, reliability, ease of calibration (preferably on site) and maintainability. Some current problems are the ability to make airblast and thermal measurements in explosive debris environment, machine explosive characterization measurements inside the high explosive itself during detonation, an do full characterization of debris (size and momentum) from encased explosive detonations.

PHASE I: Build a prototype instrument or instrument system and demonstrate its performance in laboratory scale testing.

PHASE II: Design build and test a full-scale instrument system demonstrating its performance in its intended working environment. This may involve coordination with DSWA to schedule testing in a simulator.

COMMERCIAL POTENTIAL: Metrology, blasting operations, earthquake studies, radiation testing/monitoring, large structure (e.g., buildings, dams, and mines) integrity, fire protection, lightning protection, hazardous waste containment.

REFERENCES:

(1) DNA INWET conference Announcement Brochure, 1993 and 1991
(2) Glasstone and Dolan, The Effects of Nuclear Weapons, 1977
(3) EM-1, Capabilities of Nuclear Weapons
(4) DASIAC-SR-92-0006, Guide to Nuclear Weapons Effects Simulation Facilities and Techniques - 1992 Edition

DSWA 97-009 TITLE: **X-Ray Effect Simulation Technology**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative technologies for the production of x-ray radiation.

DESCRIPTION: Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5keV), warm x-rays (5-15keV), and hot x-rays (>15keV). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.

Present Plasma Radiation Source (PRS) generate copious amounts of debris (material, atomic charged particles, sub-keV photons). Debris production is an even greater concern for the simulators currently under development. New measurement and analysis technologies are required to characterize the source and the debris generated from wire array and z-pinch PRS to better understand debris sources and mitigation. Existing debris shield technologies are not adequate to support larger exposure areas and cleaner test environments while minimizing fluence degradation. New methods, or combination of methods, need to be developed to stop, mitigate, and/or delay debris generated for radiation simulators.

New technologies to measure plasma parameters for simulator sub-systems such as plasma opening switches and plasma sources are of interest. Test response diagnostic technologies are required to measure the full time and spectral history of the radiation pulse across the breadth and width of the test asset as well as the response of the test asset during and after irradiation. Pulsed power diagnostic technologies are required for accurate, in-situ measurement of voltages and currents within the various simulator subsystems in order to monitor and characterize simulator performance. Diagnostic systems include required sensors/detectors, cabling, recording equipment and media, and if necessary, computer systems and software.

New concepts for compact x-ray sources for component level nuclear weapons effects x-ray testing are also of interest. DSWA is seeking innovative approaches for cost effective, compact pulsers with low end point voltage x-rays (100-500keV) for possible operation at service customer production facilities.

PHASE I: Demonstrate the feasibility of the proposed concept.

PHASE II: Develop, test and evaluate proof-of-principle hardware in its working environment on a radiation simulator. This will involve coordination with DSWA to schedule testing in an above ground test simulator.

COMMERCIAL POTENTIAL: Nuclear instrumentation, very fast closing valves and bright x-ray sources.

REFERENCES: DASIAC-SR-92-0006, Guide to Nuclear Weapons Effects Simulation Facilities and Techniques - 1992 edition

DSWA 97-010 TITLE: **Distributed Interactive Simulation of Nuclear Weapons Effects**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Incorporate nuclear weapons effects and adapted nuclear effects technology into the Distributed Interactive Simulation (DIS) protocol

DESCRIPTION: Nuclear Survivability testing of new acquisitions and design modifications can be accomplished prior to 'bending metal' through the use of the Distributed Interactive Simulation protocols and battlefield synthetic environment "testing". However, such assessments require validated systems models, nuclear environments and response algorithms; all capable of operating within the approved set of DIS protocol data units (PDUs).

Improved methods for nuclear environmental and effects representation within the DIS protocol are needed to calculate and assess such nuclear effects on systems (equipment and personnel) as prompt radiation (gamma, s-ray and neutron), protracted radiation, airblast, ground shock, water shock, cratering, thermal radiation, electromagnetic pulse, blackout and redout.

There have also been adaptations of nuclear effects technology to non-nuclear applications. Included are disaster planning tools for such natural disasters as hurricanes and earthquakes. Improved methods for representation of natural disaster damage and its impacts within the DIS protocol are needed to facilitate visual representation of the disaster and to train emergency managers/responders for appropriate responses.

PHASE I: The research will demonstrate the feasibility of the proposed approach to represent nuclear environments and effects in the DIS protocol.

PHASE II: The research concepts developed in Phase I will be further developed, tested, validated and submitted for inclusion into the IEEE PDU standards.

COMMERCIAL POTENTIAL: Emergency Management Training

DSWA 97-011 TITLE: **Operational Planning and Targeting Technology**

CATEGORY: Exploratory Development, Communications Networking

OBJECTIVE: Improved ability of US nuclear commanders to plan for nuclear engagements and target nuclear weapons.

DESCRIPTION: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments require improvement. These improvements include development of automated planning systems; technologies to determine target damage objective and criteria; post strike target damage assessment capabilities; and automated nuclear weapon employment codes. Techniques to account for electromagnetic effects in operational planning and exercises are also desired.

PHASE I: Develop the proposed technology in sufficient detail to demonstrate its feasibility.

PHASE II: Continue the development of the proposed technology to the point it can be incorporated into existing planning/targeting methodologies

COMMERCIAL POTENTIAL: Logistics planning, shipping route planning.

DSWA 97-012 TITLE: **Verification Technology Development**

CATEGORY: Advanced Development, Sensors

OBJECTIVE: Improve/develop US technical capability to verify/monitor compliance with existing and potential future arms control treaties, agreements, and confidence and security building measures, e.g., START, INF, CW, CFE, NTT, SNF, CTBT, CCWC, Open Skies and Presidential Initiatives

DESCRIPTION: New arms control measures are being negotiated. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations or provide confidence building information. One problem will involve being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor. Another might include providing information to reduce tensions or intervene in crises.

PHASE I: Demonstrate the feasibility of the proposed technology in relation to potential arms control or confidence building application.

PHASE II: Develop a proof of design to demonstrate the proposed technology.

COMMERCIAL POTENTIAL: Inventory Systems, Chemical Monitoring Systems

REFERENCES: Program Plan for Research, Development, Test and Evaluation for Arms Control Cooperative Inspection FY93-95, OUSD(A), 4 Jan 93

DSWA 97-013 TITLE: **Counterproliferation Technology**

CATEGORY: Exploratory Development, Sensors

OBJECTIVE: Develop new technologies for countering the proliferation of weapons of mass destruction

DESCRIPTION: In support of the Department of Defense counterproliferation initiative, the Defense Special Weapons Agency (DSWA) is interested in identifying and integrating proven and maturing technologies to develop and demonstrate an operational capability to counter the proliferation of nuclear, biological , and/or chemical (NBC) weapons of mass destruction (WMD) located in a spectrum of facilities. Specifically, DSWA is interested in initiatives in the following technical areas:

Hardened Target Defeat. Develop physical/functional lethality criteria for conventional weapons, including precision guided munitions, and advanced non-nuclear weapon payloads. Of particular interest are the development of shaft and portal vulnerability models. The models will be validated via weapon testing against simulated NBC targets.

Proliferation Path Analysis. Develop analytical models to predict the activities needed for development of NBC weapons programs by rogue nations. The model will alert DoD to potential proliferation activities and identify vulnerable chokepoints in the proliferation process for option development possible exploitation.

Enhanced Conventional Weapons Payloads Concepts. Develop concepts for the use of non-nuclear payloads delivered by penetrating weapons and released inside hardened NBC research/production/storage facilities to provide a significant increase in effectiveness (i.e., functional kill) over current conventional high explosive warheads. Of particular interest are payload concepts limiting the production of blast and high pressure gases, reducing collateral damage or nuclear/biological/chemical agent dispersal.

Collateral Effects Prediction Technology. Develop technology to define and predict weapon and target environments that cause unintended casualties. Of particular interest are improved atmospheric transport and dispersal models to provide significantly improved meteorological predictions along with embedded source terms and transport models. The effort will also provide validated models to rapidly assess the effects of a strike on a NBC facility. End product will be a deployable collateral effects assessment capability for planners, decision makers, and users.

Targeting Technical Assistance. Develop technology to assist the theater user in conducting pre-attack weaponeering (including collateral effects prediction/mitigation) and post-attack battle damage assessment. Areas of emphasis include development of tools for proliferation path analysis, target planning, and collateral effects

prediction/mitigation. End product will be a deployable expert system for operational planners using analytic prediction tools, multimedia hypertext databases, and technical manuals in concert with applied research, with possible sensor data use for condition updates.

Target Signature Evaluation. Develop sensor technology and analytical procedures for NBC target pre-attack characterization by understanding the operational aspects of target facility missions, architecture, prime mission equipment, critical subsystems, and functional vulnerabilities. The sensors must also provide data on weapon performance and reliable battle damage assessment. Of particular interest are air-dropped or man-emplaced unattended ground sensors, including hyper-spectral, seismic, thermal, electromagnetic, acoustic, gravimetric, and chemical.

Agent Neutralization. Provide a basic understanding of chemical and biological weapons response to weapons environments. Specifically, provide data and models describing the neutralization of threat agents to thermal, shock, and ionizing radiation environments. In addition, define the collateral effects source terms (quantity of agent released in viable form) of downed hostile cruise missiles carrying biological agent payloads.

Counterproliferation Advanced Concept Technology Demonstration (ACTD) Phase I, DSWA will continue its basic research to complete the development of codes and analytical models for weather, collateral effects, target/weapon interaction described above.

Phase II, DSWA will identify promising technologies to be used.

Phase III, the end-to-end ACTD will be conducted. The ACTD will feature pre-attack site characterization using sensors and analytic tools. High-fidelity targets (simulating hardened WMD targets) will be attacked using a variety of advanced conventional payloads to evaluate penetration, lethality, and collateral effects. Sensors will also be used to determine weapon performance and battle damage assessment.

COMMERCIAL POTENTIAL: Characterization and warning sensor technology. Software decision and tracking models. Environmental modeling. Structural Dynamics predictive tools.

REFERENCES:

(1) Presidential Decision Directive/NSC-13 (Classified Subject)
(2) SECDEF remarks to the National Academy of Sciences Committee on International Security and Arms Control, 7 Dec 1993 ("The Five Dangers").
(3) Deutch, Report on Nonproliferation and Counterproliferation Activities and Programs, May 1994.
(4) 1992 Defense Science Board Summer Study on Technical Military Capabilities for future Contingencies: Countering Weapons of Mass Destruction in Contingency Operations, March 1993.

DSWA 97-014 TITLE: **Pulsed Power Technology and Applications**

CATEGORY: Exploratory Development, Energy Storage

OBJECTIVE: Dramatic improvements in energy storage, switching, and power conditioning technologies.

DESCRIPTION: Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state-or-the-art. Innovative approaches for component or subsystems development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed Power applications include operation at kilovolts to megavolts, kiloamperes to megaamperes, and repetition rates from single pulse to 10 kilohertz. New diagnostics used to enhance the operation of the various pulsed power elements are required.

Recent advances in energy storage and switching technologies now make possible the application of DSWA pulsed power technology to such areas as armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; air, surface, and subsurface systems; high power microwave weapons;, etc. Concepts for new applications of pulsed power should be highly innovative and make full use of the emerging pulse power technology.

PHASE I: Demonstrate the feasibility of the proposed concept.

PHASE II: Develop, test, and evaluate proof-of-principle hardware.

COMMERCIAL POTENTIAL: Compact power devices to clean up smoke stack effluents and environmental pollution control, metal cutting and electric vehicles.

REFERENCES:
(1) Pulsed Power Symposium
(2) EML Symposium

DSWA 97-015 TITLE: **Directed Energy Effects**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of directed energy and develop survivability technologies to mitigate these effects.

DESCRIPTION: The effects of directed energy sources such as lasers, neutral particle beams and charged particle beams on materials, structures and systems are of interest to DSWA. Of particular interest are the establishment of the correlation between nuclear weapons effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and the interaction mechanisms of directed energy sources actually interact with target materials/structures.

PHASE I: Demonstrate the feasibility of the proposed investigation.

PHASE II: Characterize the effects of directed energy on materials, structures, etc.

COMMERCIAL POTENTIAL: High energy welding

DSWA 97-016 TITLE: **Forecasting Environments in the Troposphere and Space (FORETS)**

CATEGORY: Exploratory Development, Environment Effects

OBJECTIVE: To investigate the effects of the natural and disturbed environments on atmospheric and space forecasting methods. Develop techniques to mitigate these effects, account for physical processes contributing to chaotic environments, and improve performance predictions.

DESCRIPTION: The Defense Special Weapons Agency (DSWA) is interested in the basic physical process which describes the effects of the natural and disturbed environment on the employment of various weapon systems. These environments may create situations that degrade the propagation of communication and radar signals, optical sensor systems, and weapons system employment. Part of DSWA's mission is to predict effects the environment will have on these systems. Areas of interest include development of models and model predictions to forecast the effects of clouds on the theater of operations: the identification and streamlining of a model for support of theater operation: the development of a coupled space weather model to predict particle fluences and spectra; and the development of cloud and scintillation climatologies.

PHASE I: Demonstrate the feasibility of the proposed areas of investigation to advance the understanding in any one of the areas.

PHASE II: Continue the investigation leading to the development of models/products that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Weather prediction.

REFERENCES:
(1) Journal of Atmospheric Sciences
(2) Journal of Geophysical Review

(3) Radio Science
(4) Weather Review

DSWA 97-017 TITLE: **Advanced Lethality Technologies**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Demonstrate innovative applications of advanced non-nuclear technologies for enhanced target lethality or nuclear effects simulations

DESCRIPTION: Of interest to DSWA is the development and demonstration of capabilities which may significantly extend weapons range-to-effect or enhance lethality against hard targets. The response of a hardened bunker complex or of intrinsically hard ballistic missile sub-munition warhead payloads are of particular interest. Novel applications of explosives technology, hyperkinetic technologies, or directed energy (DE) concepts will be of interest.

PHASE I: The research will develop concept feasibility through either analysis or laboratory scale demonstration.

PHASE II: The concepts will be further developed through more definitive experiments and/or sophisticated computational analyses.

COMMERCIAL POTENTIAL: Hypervelocity, advanced explosives.

DSWA 97-018 TITLE: **Field Expedient Hardening**

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative methods that would temporarily harden military and civilian equipment to nuclear weapon effects.

DESCRIPTION: Innovative methods to temporarily harden military and essential civilian equipment to the effects of nuclear weapons are of interest. Installation should be relatively easy and quick (hours to a few days) an provide protection for several months to a year. Such hardening methods must be practical for field equipment and allow operation of the system.

During Phase I the research will develop concept feasibility through either analysis or laboratory scale demonstration.

During Phase II the concepts will be further developed through more definitive experiments and/or field demonstrations.

COMMERCIAL POTENTIAL: Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) protection, lightning protection.

REFERENCES:
(1) Mil-Std-188-125
(2) Mil-Hdbk-423
(3) EM-1, Capabilities of Nuclear Weapons
(4) Glasstone, The effects of Nuclear Weapons

DSWA 97-019 TITLE: **Advanced Space Nuclear Power and Propulsion Technology**

CATEGORY: Exploratory Development, Propulsion and Energy Conversion

OBJECTIVE: Demonstrate innovative approaches to space power and propulsion technologies that use space nuclear reactors as the power source. Nuclear fuel technology is excluded from this effort.

DESCRIPTION: The Defense Special Weapons Agency (DSWA) is interested in the development and demonstration of capabilities that extend the maturity of the U.S. space nuclear power and propulsion technology base. Technologies supporting power-only, propulsion-only, and bi-modal (power+propulsion) are of interest. Particular interest for power technologies is in static conversion processes. System level research is no included in this effort, nor is nuclear fuel technology.

During Phase I the research will develop material, component, or sub-component feasibility through analysis or laboratory scale demonstrations.

During Phase II material, component or sub-component will be further developed through more definitive experiments, analysis and/or life testing.

COMMERCIAL POTENTIAL: Supports high-powered (>10kWe) satellites, space-tug concepts, launch vehicle step-downs for massive satellites.

DSWA 97-020 TITLE: **Nuclear Weapon System Safety Assessments**

CATEGORY: Exploratory Development, Nuclear Related Technologies

OBJECTIVE: Improved safety of US nuclear and other weapons

DESCRIPTION: Quantifying, reducing, and managing the risks associated with the life-cycle management of US weapons is of vital importance. New and innovative concepts to improve on traditional probabilistic risk assessment techniques and methodologies, as well as operations are desired to increase the overall safety of these assets. Abnormal environments that may be encountered include mechanical insults (e.g., drops, vehicle accidents), thermal insults (e.g., fuel fires), electrical insults (e.g., lightning, electrical power), and combinations of these environments. Long range program thrusts include characterizing these abnormal environments, analyzing human factors and developing quick running models to allow decision makers to manage safety risks. Concepts should employ innovative ideas and make use of new and emerging technologies. Work will include measurement improvements, risk reduction techniques, and advanced algorithms for improved quick-look capabilities.

Measures to improve the safety of nuclear and other weapons against all possible abnormal environments are required. Safety enhancement measures include prediction of events through characterization of initiators and eliminating/mitigating such initiators. Proposals should describe how they will improve protection against known and predicted risks and should emphasize risk elimination/reduction where appropriate.

PHASE I: Demonstrate the feasibility and potential usefulness of the proposed safety technologies/techniques.

PHASE II: Fully develop the proposed technologies/techniques so they can be compared to existing techniques.

COMMERCIAL POTENTIAL: Data risk assessment and management models potential for adaptation to a variety of users. Risk models can be used in evaluating manufacturing alternatives, optimizing safety budgets and equipment, to reducing risks in the home or comparing potential alternate decisions.

REFERENCES:

(1) Joint DoD/DOE Surety Plan, August 1991
(2) Report of the Panel on Nuclear Weapons Safety, DEC 1990

DSWA 97-021 TITLE: **Multi-Source Data Fusion for Monitoring to Detect Nuclear Tests**

CATEGORY: Comprehensive Nuclear Test Ban Treaty (CTBT)

OBJECTIVE: Prototype innovative techniques for detecting and characterizing patterns of interest across large, heterogeneous databases to improve the capability to monitor for violations of the Comprehensive Nuclear Test Ban Treaty.

DESCRIPTION: The impending completion of the Comprehensive Nuclear Test Ban Treaty (CTBT) has focused attention on the technical challenges of monitoring to detect evasively conducted nuclear tests, and discriminating between such tests and other events, such as earthquakes or mining activities. Monitoring the CTBT, which prohibits testing in all environments, will require the acquisition, management, fusion, interpretation, and presentation of data from heterogenous sources and of heterogenous types. The resulting databases will include the following classes of data: time and space series, imagery, text and speech, and more complex types (e.g., video, analog data, etc.). DSWA seeks a prototype system to support robust data fusion, including the detection and characterization of interesting temporal and spatial patterns across these data classes. The prototype should focus initially on the four components of the International Monitoring System (i.e., seismic, hydroacoustic, infrasound, and radionuclide monitoring) and be extensible to broader databases, including satellite imagery, EMP, HUMINT, etc. The prototype should operate initially within, and take advantage of, the systems infrastructure of the prototype International Data Center (IDC) being developed by the Nuclear Treaty Program Office, and be extensible to final IDC in Vienna, Austria. Techniques in the related areas of data fusion, knowledge discovery, database mining, and data visualization should be considered. Prototypes that demonstrate automated and/or interactive (human driven or assisted) data fusion and decision support are of interest.

COMMERCIAL POTENTIAL: Data fusion techniques to support areas involving high volumes of disparate data, e.g., the airline, mining, or medical industries. A potential military application would be for battlespace management.

REFERENCES:
(1) Draft Comprehensive Nuclear Test Ban Treaty, CD/NTB/WP.330/Rev.1, 28 June 1996.
(2) Conference on Disarmament Working Papers on the International Data Center, CD/NTB/WP.293, 294, and 312.

DSWA 97-022 TITLE: **Tracking Atmospheric Plumes Based on Stand-Off Sensor Data**

CATEGORY: Comprehensive Nuclear Test Ban Treaty (CTBT)

OBJECTIVE: Develop an approach to identifying and locating the source of nuclear events that generate atmospheric plumes by backtracking their atmospheric plumes.
DESCRIPTION: An essential element of the International Monitoring System (IMS), being established to monitor compliance as part of implementing the Comprehensive Nuclear Test Ban Treaty (CTBT), is the radionuclide subsystem. The collection component of the stations of the subsystem will continuously sample the atmosphere. Periodically (e.g., every six hours) a sample will be completed and analyzed by the radionuclide detectors and their supporting systems. The results of the analysis will be transmitted to regional and/or national data centers, and/or on to the International Data Center (IDC). Analysts and/or their support systems need to be able to determine the source of those samples of interest; i.e., those that contain either certain radioactive products and/or abnormally high levels of other radioactive products. The source includes the identification and location of the nuclear-related activity that produced the radionuclide(s).

This research initiative seeks solutions (or contributions there to) to determining the likely location of the source with an immediate accuracy of within an area as small as 1,000 sq. kms (ultimately perhaps as small as .5 kms by .5 kms).

Solutions should incorporate those characteristics related to nuclear materials/products (e.g., their weight, fractionation, and recombinant potential) and the parameters associated with weather and/or climate (e.g., velocity and

direction of wind currents, temperature gradients and rain) that appear to control or influence the transport and dispersement of nuclear materials/products.

It is anticipated that solutions will leverage past work on fallout and atmospheric modeling. Fallout analysis and prediction work, particularly that done during the period when atmospheric nuclear tests were allowed (approximately 1946 to 1962) and perhaps additional work related to leaks during underground testing as well as from such unfortunate events as the Three Mile Island (in Pennsylvania, USA)and Chernobyl (Russia) accidents, should be considered. Atmospheric transport models should be identified and reviewed to see what factors they use as inputs and how up to date they appear to be, etc.

Solutions may automate the integration of meteorological and climatological data with quantitative data from stand-off sensors (biological, chemical, nuclear, etc.) to rapidly detect hazardous material plumes, characterize plume morphology, backtrack to the plume's source, and predict future plume propagation.

An added dimension will be determining the availability of historical data as well as current data collection activities, particularly as related to monitoring areas of interest to the United States.

COMMERCIAL POTENTIAL: Environmental monitoring, including power generation plants (both nuclear and non-nuclear) and weather, and air travel safety.

REFERENCES: Draft Comprehensive Nuclear Test ban treaty, CD/NTB/WP.330/Rev.1, 28 June 1996.

DSWA 97-023 TITLE: **Multi-Dimensional Visualization of Data to Identify Seismic Events or for Other Complex, Multi-Dimensional Data Problems**

CATEGORY: Comprehensive Nuclear Test Ban Treaty (CTBT)

OBJECTIVE: Develop a visualization subsystem for the discrimination of different types of detected seismic events; test the subsystem with the Nuclear Treaty Programs Office's (NTPO's) Intelligent Monitoring System; and demonstrate the subsystem's potential application to other multi-dimensional data problems.

DESCRIPTION: NTPO is developing a global system for monitoring nuclear proliferation activities and for potential use in verifying compliance with a Comprehensive Nuclear Test Ban Treaty (CTBT). The system will collect data from a worldwide network of seismic stations and arrays, as well as sensors deployed for air, particulate, and other types of environmental sampling. The seismic system alone will have to process data from several hundred monitoring stations for tens of thousands of detected earthquakes and explosions per year. Results of the final analysis must be available within 24-48 hours of the occurrence of the events. Achieving this goal within the available resources will require automatic data processing and an enhanced data interpretation capability. NTPO is exploring technologies such as machine learning, machine discovery, and visualization methods to aid in the data interpretation.

This initiative seeks subsystems implementing novel visualization techniques and components to aid in interpreting the results of multi-variate seismic discrimination analysis, particularly for small seismic events detected at regional distances out to 2,000 km. The subsystems will be installed in the Intelligent Monitoring System at NTPO's Center for Monitoring Research (CMR) located in Rosslyn, Virginia, and tested with data acquired and processed by the Intelligent Monitoring System. The performer will demonstrate how the visualization techniques can be applied to the general problem of monitoring the proliferation of weapons of mass destruction by demonstrating that it is capable of aiding human analysts in interpreting data from the global seismic monitoring system. The performer will also demonstrate how the techniques can be used to solve other problems involving such data.

COMMERCIAL POTENTIAL: Visualization subsystem to aid in the solution of generic multi-dimensional or multi-variate problems. This could include topics ranging from environmental monitoring to air traffic control.

REFERENCES:
(1) Draft Comprehensive Nuclear Test ban treaty, CD/NTB/WP.330/Rev.1, 28 June 1996
(2) Conference on Disarmament Working Papers on the International Data Center, CD/NTB/WP.293, 294, and 312.